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ABSTRACT

In the fall of 1996, the Computer Science Department at Virginia Tech initiated a joint project with the Montgomery County Public Schools in Virginia to determine how ready access to networked computing in the fifth grade would affect long-term student achievement. This project examines what can be achieved if technology access, support, and curriculum integration can be eliminated as obstacles or constraints in the classroom and at home. To accomplish this, a high-tech classroom was designed at Riner Elementary School in which the technology is as ubiquitous as the furniture. A computer was sent home with each child and teacher and as much support as necessary was provided to all program participants, including parents. After a year of immersive exposure to a technology-rich classroom, the children continue in a conventional sixth grade classroom but keep their computers at home. This paper focuses on design and cost issues related to the dually constructivist learning environment created for the project, and describes experiences to date. (Author/AEF)

Paper Session

Design of Technology-Based Learning Environments That Support Both Teachers and Students

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Abstract

Many teachers across the country have seized on networked computing as a way to improve their effectiveness. Through such techniques as project-based learning and redesigning the classroom process to support collaboration and spontaneous inquiry, teachers are capitalizing on technology to create excitement and a new positiveness toward learning among their students.

Network technologies appear particularly effective in facilitating the development of child-centered, constructivist learning environments. The skills needed to create such environments are not easily learned. Thus, we will have to be innovative about

how we nurture and encourage teachers and schools to adopt styles that are really quite foreign to them. The current panacea is extensive teacher training. We argue that schools need to become teacher-centered, to build constructivist environments for their teachers that encourage exploration, experimentation, and pedagogical innovation.

In our PCs for Families program (http://pixel.cs.vt.edu/edu/fis/) we are working on such a dually constructivist classroom. We describe the design issues, the cost, and our experience to date with our technology-rich home-school environment.

Introduction

In the fall of 1996, the Computer Science Department at Virginia Tech initiated a joint project with the Montgomery County Public Schools in Virginia to determine how ready access to networked computing in the fifth grade would affect long-term student achievement. With the support of the U.S. Department of Education, we are interested in learning what can be achieved if technology access, support, and curriculum integration can be eliminated as obstacles or constraints in the classroom and at home. To do this we designed a high-tech classroom at Riner Elementary School in which the technology is as ubiquitous as the furniture. We send a computer home with each child and teacher and provide as much support as necessary to all program participants, including parents. Ours is the educational equivalent of the Homenet project at Carnegie Mellon University (Kraut et al., 1997) which studies the effects of giving technology and support freely to ordinary Pittsburgh citizens. After a year of immersive exposure to a technology-rich classroom, our children continue in a conventional sixth-grade classroom but keep their computers at home. We will track our students for several years to determine the effects of their experience on their achievement and on their qualitative success in defining and achieving personal and educational objectives.

In this paper, we focus on issues related to the dually constructivist learning environment created for the project. We believe that in such a learning environment, long-term increases in educational efficacy will be fostered and sustained.

Project Impetus

Network technology is increasingly being incorporated into classrooms across the country and is hoped to increase educational efficacy and long-term achievement gains on the part of the students. However, this influx of technology has fueled a national debate as to the real benefits of the resulting educational transformation. Schools deploy network technology using resource-limited models and seldom have the means to fully evaluate the impact of the technology on the students (Shaw et al., 1997).

Another issue in the national debate over the effectiveness of the current technology thrust in the schools concerns the ability of teachers to leverage the potential that computers may offer to enhance classroom learning. Not only is the technology new to many teachers, but many may have difficulty integrating it into their lessons. Cuban (1986) and Tyack and Cuban (1996) have placed much of the blame for the failure of earlier technologies on "top-down" deployment in which teachers have not

been significant participants in the planning and integration process. Unrealistic conditions of access, support, and basic utility, coupled with lack of appreciation for the culture of the classroom and the stringent demands on the teacher, prevented many technologies from becoming significant vehicles for educational reform.

Further, relatively few teachers have mastered constructivist pedagogy, which appears to be one of the principal learning styles supported by computer technology. The degree of success achieved by the computerization of schools may well depend on the ability of teachers to shift to this new pedagogy (Shaw et al., 1997). However, as with the technology, teachers are often being asked to accomplish this transformation without the benefit of sufficient training or other support mechanisms.

The PCs for Families project has attempted to address these issues by (1) eliminating resource constraints commonly associated with the growth of classroom technology, (2) actively involving teachers in the deployment process, (3) providing the teacher with ongoing support for integrating network technology into the educational process, (4) partnering the teacher with a master constructivist teacher during the early stages of the project, and (5) having researchers take responsibility for evaluating the impact of this educational transformation. We set out to determine if under the best of circumstances ubiquitous access to network technology results in long-term achievement gains under the assumption that if such a resource-rich approach did not result in measurable improvements, resource-limited models were unlikely to be successful.

Project Approach

In the PCs for Families project, we took the view that we needed to design a constructivist learning environment for our teacher and nurture her as she nurtured her own charges, thus allowing her to realize fully the potential of the new technology. A major redesign of the physical classroom as well as the educational protocol was required to accomplish this goal. To do that required technical, educational, and administrative support, which was to be provided by three principal investigators who represented broadly diverse areas of expertise in technology, education, and administration. One was a computer scientist, another was a master constructivist teacher, and the third was the school principal at Riner. Time was a major constraint because the new learning environment needed to be online and functional within two months of project initiation.

We were not interested in a laboratory classroom model. From the outset, our goal was to change our fifth-grade classroom into the best constructivist learning environment we could reasonably provide. We reasoned that because spontaneity is such a basic characteristic of a constructivist classroom, we needed an environment that would support not only intentional learning but also the joy of spontaneous discovery. A child wrapped up in discovery is infectious, and it was important to us to design a classroom that would encourage collaboration and the propagation of excitement within the class. We also wanted to capitalize on the immediate availability of information so that the instant a question was posed, the children would be busy searching for answers. Therefore, computers always had to be within reach and ready for use throughout the school day. At the same time, we didn't want the technology to be obtrusive.

Working With the Teacher

The physical classroom was designed by the teacher, technology specialist, and staff members working together in a process known as *participatory design* (Gronbaek et al., 1993). The goal of participatory design is to produce a superior design by teaming interdisciplinary specialists with the domain expert, who is the teacher. First, typical classroom scenarios are constructed and then alternative designs are conceived and evaluated against the scenarios. Together, team members constructed these scenarios, considering where the children would be focusing attention, how they would be collaborating, and what resources they would be using. They considered lighting, visibility, sound, working spaces, and accessibility using drawings with paper cutouts to produce designs they could evaluate. They selected the furniture, color scheme, placement, storage, flooring, and wiring. Even issues such as static electricity, chair rollers, and workplace ergonomics were considered. As the year progressed, adjustments were made as necessary, and special furniture was also designed to support new needs that arose, such as a teacher demonstration station.

While equipment was arriving, we focused on the changes in teaching style that our teacher had to master. Most school technology programs are based upon inservice training; because of the many problems with this model, we decided instead to adopt an apprenticeship model in which a technology specialist would work in partnership with the teacher to provide support and ideas without dominating the teacher or altering her basic role as educator. We have avoided forcing technological details on our teacher so that she could focus on conducting her class. Our method has been to bring the potential of various technologies to the attention of the teacher, sometimes proposing small experiments but without requiring technology adoption. We provide the teacher and her technology partner with computers and free networking at home, and we provide a software budget and a base of installed programs with which they are free to experiment without obligation.

Our classroom teacher, Susan (we use the real names of project staff but fictitious student names), was among the 13 key teachers who participated in discussions and pilot activities during the NIE project. Susan is an experienced professional, reserved, dedicated, and intrigued by the possibilities offered by technology-supported education. Until joining our program she specialized in the fifth-grade Comprehensive School Math Program at Riner. Like a number of her contemporaries she had been trained to use e-mail from her DOS-based PC at school through dialup connections to VaPen, Virginia's public education network. By the time the PCF project started, she had a Macintosh 6100 in her classroom, connected by a T1 connection. Her classroom itself is located in a 25' x 35' trailer that supports 24 students, one of several in use because of a serious space shortage at Riner. Thus, the project began in a rather unremarkable setting that might be typical of educational settings across the country.

Like most teachers, Susan is obligated to cover state-mandated curricula (called in Virginia, the Standards of Learning), plus local additions such as Drug Abuse Resistance Education. Therefore we decided that we would not teach technology during regular class time except when it is essential or related to state mandates. Instead, we have met with the children after school one hour per week. That has

reduced the stress on regular class time, and it provides a time when we can experiment more freely with teaching techniques and technologies. It is important to note, however, that responsibility for the after-school sessions is not heaped on our classroom teacher. This program is carried out by the technology specialist.

One of the problems often faced by a teacher attempting to pioneer major classroom changes is the lack of a peer group and the lack of time or opportunity for discussions with colleagues. It therefore fell to Melissa, one of our investigators, a master teacher, to act as mentor and collaborator on educational issues during the first few months when the most dramatic changes in teaching style were taking place. Melissa would present at least one lesson a week to show how computers could be woven naturally into lessons and subsequent student work. Thanks to Melissa's examples, Susan made dramatic progress and mastered the new techniques within an exceptionally short period of time.

Once our design was in place, we continued to learn as we went along. For example, it was soon obvious that the student pairing at the computers was volatile. Partnerships would just wear out and would have to be changed. That created logistical problems associated with moving a student's files from one computer to another. The hardest problem at first was that of moving mail accounts from one computer to another. Such things are technology-induced problems that have nothing to do with the instructional process but add considerable burden to the teacher's load without contributing to educational activity. So we built our support system to address and resolve these problems for the teacher.

It is extremely frustrating to a teacher to design a lesson that relies on technology, only to have a major failure a few minutes before show time. Since a technology specialist is always available, we were able to decrease the frequency of problems and have someone on hand to resolve them while the teacher manages the class. It is also the case that in a truly constructivist classroom there is always uncertainty about what will happen next. The technology specialist is the key to fast turnaround, help in class, and assistance with unplanned adventures.

Many teachers are wary of making extensive classroom use of electronic mail. On technological grounds alone, managing mail accounts can be sufficiently frustrating and time consuming that teachers might well be discouraged from its use. In our case, we felt strongly that teaching our children communication skills and building an ethical foundation was extremely important. Also, we wished to learn more about the use of such capabilities for building a community, not only among our students, but within and among our participating families. Therefore, we are making every effort to support electronic mail and strongly encourage its use. In the process we are able to teach our children things that are grossly misunderstood even in the adult world, such as the unreliability, awkwardness, and security dangers associated with e-mail attachments.

The result of e-mail use is an astonishing increase in the teacher's workload due to the flood of mail that occurs. And this is good. The children learn quickly. They think, they organize, and they write, but teachers find that criticizing electronic homework submissions is very time-consuming work that cannot be done at odd times on the porch or in front of the TV set but only in front of the computer screen. Only the rare teacher will deal with the extra burden this imposes on his or her life.

We attempt to reduce this burden by providing all the technical support, and the technology specialist spends many hours a week as a prime communicator.

Thus, we have worked hard to ensure that the teacher would maintain control over curriculum and classroom protocol and not become discouraged or diverted by technological issues that have no direct bearing on her job. We have found administrative support critical to this process. When a teacher is in the process of rethinking a pedagogical style that has evolved over 20 or 25 years, encouragement, enthusiasm, and unqualified support are essential. The principal must be the cheerleader and the contact person for all of the many physical and logistical needs required to maintain a technically functional classroom. In our case, the teacher was especially aware of affairs and stresses within our participating families. From her vantage point, the relationship between a child's performance and family performance becomes magnified. It is important to the teacher that a strong and committed principal is prepared to intervene directly with the families in cases where a child's performance has become at risk. The principal must deal unequivocally with problems of ethical behavior related to the technology and must stand behind the teacher in the enforcement of student performance standards and classroom behavior.

What Actually Happened

When our project began, our very first concern was to make the right decisions about the classroom design. Giving the classroom teacher design authority is an excellent first step toward giving the teacher a sense of ownership and control. Besides that, an experienced teacher will have excellent intuition about what will work and what won't. The classroom went online in seven weeks, and the basic design has endured. Computers were delivered to the families three weeks later, and by Christmas, Susan had gained much confidence in her new teaching style.

In a classroom this small, the students are always near their computers, and it was difficult at first for the students to leave them alone when their teacher would try to address them as a group. Susan experimented with various techniques for decoupling the students from their computers and would have preferred a master "freeze" button at her desk. The second year, tables were clustered more tightly to make room for a small technology-free group space.

Among our goals was the desire not to teach technology by itself but rather to introduce it naturally in support of genuine pedagogical needs. Moreover, we decided to introduce the children to an adult environment and to try to teach them deeper ideas about information and ethics. Technology introduction was staged according to the needs of the teacher. The World Wide Web was introduced almost immediately since it was to be a basic information source. Next came word processing, then e-mail, then image processing. Along the way the students began to make their own discoveries and taught themselves about such things as sound processing and PowerPoint. In fact, the students discovered PowerPoint before the teacher, which impressed her so much she went home and taught herself. This resulted in a major class production on the story of the Titanic, ending with a formal presentation. Finally, near the end of the school year came FTP and World Wide Web publishing.

As for the deeper issues, the World Wide Web is a natural means for introducing global awareness to our students, who entered with a very local perspective of the world. Much time was spent discussing the credibility of information that one finds on the networks and what one might do to increase one's confidence in information by seeking consistent sources. Ethics were taught over and over again by each staff person, and an entire parent meeting was devoted to the subject so that the parents could reinforce what was taught at school. Whether or not our children choose to abide by the ethical groundwork we laid for them, each has the foundation and each understands how to make good decisions.

Things We've Learned

Technology, like books, blackboards, and crayons, are tools used by the creative teacher to build a learning environment. Network technology adds a new dimension to the classroom and raises new challenges for both teachers and learners. We have found that teachers and learners benefit from learning environments that nurture and encourage them to explore. Now in our second year, it is too early to say what the long-term impact of our dually constructivist learning environment will be. We continue to be surprised by the many different and unexpected events that occur and are constantly struggling to find explanations. Until the long-term achievement data becomes available, we must look at what happens to the children and teachers as individuals to assess the impact of our technology-rich, constructivist classroom. At this stage, our best metric is often whether or not the worlds of project participants have become larger or smaller.

At the beginning of the first year of this project, Susan's room was like any other classroom in Riner. The children had typical desks, reference resources, notebooks, and pencils. The students themselves were typical fifth graders, except that they entered our class by lottery. Much of that changed with the advent of the computers and classroom setup almost two months into the school year. In particular, we would like to relate the stories of two pairs among a number of our first-year students whose lives have changed.

The first pair, Mike and Tom (fictitious names), were about as opposite as two children could be. Mike was on the heavy side, played the class clown, and always put himself down intellectually and physically. Tom was very lean and very quiet, to the point of rarely talking to the other students, even at recess. For no particular reason, they were paired at a computer almost from the start. Initially Mike dominated the computer so completely that we were concerned that Tom was not participating or learning. Over time, they began to work together, not in the way we expected to see, but in the way it worked for them. Mike still controlled the keyboard and mouse most of the time, but Tom controlled the action by pointing and discussing the next action they would take. This cooperation and collaboration spilled over not only into their intellectual pursuits but into emotional and self-esteem issues, too.

Mike became the computer expert. The class clown with his low-self esteem was being replaced by the class problem solver with his computer expertise. He became the student others would ask for advice. Tom began to talk and interact with the class a little more, but more importantly, he found an outlet for the words he was so timid to speak aloud. He found the word processor. He wrote, and he wrote, and he

wrote. Mike and Tom became good friends and better students through their experiences and collaboration in the classroom.

The second pair of students were Angie and Karen. These two were very similar in family background and educational level. Both lived in trailers in very rural settings. Neither had ever thought about or believed they could attend college, nor did they sense any particular use for school or education in general. They were very quiet and, to a large degree, loners. They seemed to get along and were therefore paired together at a computer. Again, during the course of the year, they blossomed at many levels. As their computer skills increased they began to work diligently not only to complete their assignments but to complete them on a higher level then they had ever strived for. Angie, in particular, was incredible. Her curiosity was insatiable, and her questions endless. Almost a month before we started Web pages and HTML, she e-mailed the technology specialist asking her to look at the home page she had created on the Internet. Angie was on the computer at home so much that the family finally stretched their budget enough to install a second phone line. Both Angie and Karen are now involved in their own educations; they are asking questions, looking to the future, and doing their best in school.

Not all children enjoy working with computers, of course, but even those who don't seem to have achieved some level of competence. Most of our students, who are now in sixth grade, continue to check their mail and use the World Wide Web. However, several of our children have completely dropped their use of networking, while others who were headed for academic failure have become so engaged that their perspectives and goals have completely changed. Overall, we found tardiness decreased significantly from fourth grade, and we look for this trend to continue as the students move onto sixth grade. Our students now perceive college as an important part of their future, with students rating the importance of college on average at 5.9 out of 6. They enjoy school and rank their enjoyment at 5.0 on a scale 0–6. Of the 16 children surveyed, 13 said they would consult the Internet if they needed to know what is playing at the local movie theater or the number of Virginia representatives in Congress.

Interestingly, both children and teachers perceived substantially less effort by the parents in support of the program than did the parents themselves, with support declining as the year progressed. Possible clues about our observations come from Smrekar's (1996) excellent ethnographic studies of three types of schools (parochial, magnet, and public) which reveal vastly different degrees of parental commitment across the different schools with participation often related to the degree of commitment required by the school. In our project, computers were given to families who joined our classroom by random selection. There were no financial commitments or academic performance requirements for these parents, and therefore no special reason for them to feel a sense of ownership of the program or to increase their participation in school-related activities.

Teachers who visit our classroom note that our children are articulate and self-confident. Obviously these children also have a reservoir of computer skills that rival or exceed those of their peers. While these will serve them well in their jobs, in their personal lives, and in their social interactions later on, we wait with anticipation to see whether our children will use these skills to their advantage as their academic careers unfold. Not the least among our success stories is a teacher

who has become stronger and more effective and who has found new and creative ways to engage her students. She has learned much about herself and her ability to grow. She will continue to excite, to challenge, and to show a larger world to many classes to come.

As for networked computing, it serves well as a focal point for involvement in educational reform. We like computers because they are deterministic; we can estimate the hardware, software, and communications costs. We can also budget to the dollar the cost to install and maintain them. However, like many other things, the benefits we realize will depend upon how we invest our resources. The teachers are those who connect technology to learning, and we've barely begun to think about what it costs to help them do that well.

References

Cuban, L. (1986). *Teachers and machines*. New York: Teachers College, Columbia University.

Gronbaek, K., Grudin, J., Bodker, S., & Bannon, L. (1993). Achieving cooperative system design: Shifting from a product to a process focus. In D. Schuler and A. Namioka (Eds.), *Participatory design: Principles and practice* (pp. 79–98). Hillsdale, NJ: Lawrence Erlbaum Associates.

Kraut, R., Scherlis, W., Mukhopadhyay, T., Manning, J., & Kiesler, S. (1996). The Home Net field trial of residential Internet services. CACM, 39(12), 55–63.

Pressman, H. (1997, April). *Six of sixty, the first six months of the teacher-led technology challenge*. Berkeley, CA: Report to the Teachers of Berkeley.

Shaw, D.E. et al., (1997, March). *Report to the President on the use of technology to strengthen K–12 education in the United States.*

Smrekar, C. (1996). *The impact of school choice and community*. Albany, NY: State University of New York Press.

Tyack, D., & Cuban, L. (1996). *Tinkering toward utopia*. Cambridge, MA: Harvard University Press.

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